A Closer Look at Shale Development Economics*

Florent Rousset¹

Search and Discovery Article #70136 (2013)**
Posted March 25, 2013

*Adapted from oral presentation at AAPG Geosciences Technology Workshop: Shale Plays: An Integrated Approach, Houston, Texas, November 12-14, 2012
**AAPG©2013 Serial rights given by author. For all other rights contact author directly.

¹Gaffney, Cline & Associated (GCA) (dwaldo19@yahoo.com)

Outline of Presentation

Range in basin economics

Production
  • Well spacing
  • Phased development stages
  • Technology application
  • Production constraints

Costs
  • Learning curve
  • Economies of scale

Price
  • Price scenarios
  • Project resilience

Selected Reference

A Closer Look at Shale Development Economics

Florent Rousset – Gaffney, Cline & Associates (GCA)
Houston – November 13, 2012
Gaffney, Cline & Associates (GCA)

Upstream
Geophysics
Geology
Petrophysics
Reservoir
Production

Midstream
Pipeline
Process
Operations

Downstream
Chemical
Power
Marketing

Commercial
Economics
Finance
Law
Strategy
Regulatory

... averaging around 20 years of experience
Supporting the Oil and Gas Industry since 1962

**Oil & Gas Companies**

Shell bp
Marathon Oil Corporation
SASOL
TOTAL
bhpbilliton
RELIANCE Energy
Chesapeake Energy
devon
noble energy
OSAKA GAS
ExxonMobil

**Sovereigns**

PETROBRAS
KOGAS
ONGC VIDEH
PT PERTAMINA (PERSERO)
JOGMEC
JOGMEC
ECOPETROL
STATOIL
ARAMCO
PEMEX
PETRONAS
MINISTRY OF OIL
MINISTRY OF OIL

**Financial Institutions**

IFC
International Finance Corporation
Bank of America
Deutsche Bank
Merrill Lynch
European Bank for Reconstruction and Development
CREDIT SUISSE
THE WORLD BANK
JPMorganChase
Citigroup
SG Hambros
ADB
Asian Development Bank

*Non-exhaustive*
Shale Development Economics

North American shale plays
(as of May 2011)
Basin Economics Range

Dry Gas Plays Breakeven Price Range

- Marcellus
- Haynesville
- Barnett
- Eagle Ford

US$/MMBtu

Current Henry Hub Price

Note: 10% after tax rate of return
PRODUCTION
Well Spacing Drivers

Image source: Statoil
Well Spacing

- Subsurface / Drainage
  - Reservoir characteristics
  - Well design

- Dry Gas - 120 acres/per well
- Liquids - 80 acres/per well

Note: not to scale
Well Spacing

ILLUSTRATIVE

• Subsurface / Drainage
  – Reservoir characteristics
  – Well design

• Infrastructure & Access
  – Houses & roads
  – Topography
  – Offtake facilities

Note: not to scale
Well Spacing

- Subsurface / Drainage
  - Reservoir characteristics
  - Well design
- Infrastructure & Access
  - Houses & roads
  - Topography
  - Offtake facilities
- Contractual / Regulatory
  - Infill drilling permits
  - Contractual constraints

Note: not to scale
Phased Development Stages

Exploration & Appraisal

“Core Areas” Development

Later Project Life

ILLUSTRATIVE

Low

High

Mid

20% 20%

60%

10% 50%

40%

Low

High

Mid

Low

High

Mid

20% 20%

60%

Low

High

Mid

20% 20%

60%

Op Gas Rate (Mscf/d)

Normalized Flowing Time (month)

10^4

3

10^3

3

10^2

2

10^1

0

10

20

30

40

50

60

70

80

90

100
Technology Applications

- Artificial lift
- Repeated hydraulic fracturing
- Water flooding or gas cycling?
- Others

**ELECTRIC SUBMERSIBLE PUMPS**

**REJUVENATION OF VERTICAL WELL IN WATTENBURG FIELD**

Source: GCA, HPDI
Production Constraints

Barrels per day

Midstream Facility Constraint

Natural Gas Production
Production Constraints

Barrels per day

Water Production

Water Handling Facility
Other Production Variables

• Timing
  – Logistics and third party delays, including regulatory
  – Downtime (planned and unplanned)

• Volumes
  – Debottlenecking upside
  – Accounting for fuel gas usage, etc.
COSTS
Learning Curve

Exploration & Appraisal

- Learning curve starts again when moving to another area
- Well Design Tailoring

Development & Production

- Batch/Pad Drilling
- Field/Rig Crew Experience & Drilling Pace
- Technology Application e.g. drilling motor
- Leveling Off – Until the next technology breakthrough

Days to drill a well

Number of wells drilled

Costs

Costs
Pad/Superpad Economies of Scale

- Common infrastructure and surface facilities
- Reduced footprint per well
- Minimized road traffic
- Permitting synergies
- HSE oversight

Development Concept

Superpad Layout

Source: Devon Barnett Lake Benbrook - Google Earth June 2011
PRICE
During World War II [Nobel Laureate] Ken Arrow was assigned to a team of statisticians to produce long-range weather forecasts.

After a time, Arrow and his team determined that their forecasts were not much better than pulling predictions out of a hat.

They wrote to their supervisors asking to be relieved of the duty and received the following reply:

“The Commanding General is well aware that the forecasts are no good. However, he needs them for planning purposes.”
Price Sensitivity

ILLUSTRATIVE

Gas Price Scenario

Historical Gas Price

Gas Price Scenarios

High

Mid

Low

Time

US$/mcf
Price Sensitivity

Gas Price Scenario

Historical Gas Price

Gas Price Scenarios

US$/mcf

Time

High

Price Crash

Mid

Low
Price Sensitivity

ILLUSTRATIVE

Gas Price Scenario

Historical Gas Price

US$/mcf

Gas Price Scenarios

High

High Volatility

Mid

Low

Time

High Volatility
Price Sensitivity

ILLUSTRATIVE

Gas Price Scenario

Historical Gas Price

Gas Price Scenarios

Price Upside

High

Mid

Low

Time

US$/mcf

$10

$9

$8

$7

$6

$5

$4

$3

$2

$1

$0
Tailored Alternatives

- **Continue Operations**
  - Most Attractive
  - Acreage Attractiveness

- **Scale Down Operations while Meeting Lease Obligations**
  - Drilling / Partial Hydraulic Fracturing

- **Postpone or Discontinue Operations**
  - Least Attractive
  - Acreage Attractiveness

- **Relinquish**
  - Prolonged Crash

Source: GCA
Closing Remarks

Production

☑ Well spacing attributes
☑ Type curve distribution
☑ Production constraints
☑ Technology application

Costs

☑ Learning curve
☑ Economies of scale

Price

☑ Price scenarios
☑ Project resilience
THANK YOU